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Investigation of Cotton Fabrics Treated With Sericin & Cross Linking Agents

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Abstract

Sericin is a natural protein which is removed from silk in a process called degumming. In India, 250-300 tons of sericin is extracted per year and goes as waste, it has wide range of application because of it properties like antioxidant, antibacterial, UV resistant, anticoagulant and moisture retention capacity. This project is concerned with application of sericin on 100% cotton fabrics using cross linking agents like Glutaraldihyde (GD). The cotton fabric is coated with non-formaldehyde cross linking agent. It is expected that the cotton fabric will have improved moisture absorbency, and very smooth surface leading to darker dyeing using acid dyes. The use of sericin makes this suitable for applications in medical textiles. In the present work the cotton fabric has been treated with Sericin gum using Glutaraldihyde as a cross linking agent in addition to this wetting agent has been used. The treatment has been carried out in Padding Mangle machine in the temperature of 100°c for a period of 1hour. The treated sample has taken out and cured at 160oc for 2 minutes. Then the samples have tested for various properties such as Air permeability, wicking and FTIR investigations. Results shown that the air permeability of cotton fabric is high for certain concentrations of Sericin gum and when it comes to wicking the treated fabric act as water repellent.
Key words: Sericin, Glutaraldihyde, Wicking, Air-permeability, TIV

Introduction:

India is the second largest producer silk in the world and has the distinction of the producing all the four varieties of silk. Silk consists of two types of proteins, silk fibroin and Sericin. Sericin contributes about 20-30 percent of total cocoon weight. It is high content of serine and 18amino acids, including essential amino acids. There are different methods of isolation of Sericin from silk thread. Solubility molecular weight, and gelling properties of Sericin depends on the method of isolation. It has wide applications pharmaceuticals and cosmetics such as, wound healing, bio-adhesive moisturizing, anti-wrinkle and anti-aging. Degumming was carried out in an aqueous medium using high temperature, HTHP beaker dyeing machine and IR dyeing machines. The Sericin liquor extracted by using optimized conditions was converted into powder using a laboratory spry dryer keeping inlet temperature at 110^0C and the atomization pressure at 3-4kg/cm^2 [1]. As DMEHEU is a formaldehyde-released cross-linking agent for cotton fibers/fabrics which could cause irritation to skin. In this present work substitute it by non-formaldehyde released cross-linking agents such as glutaraldehyde (GD) has been used as cross-linking for cotton fabric.

Fig 1: Raw Silk Cocoon

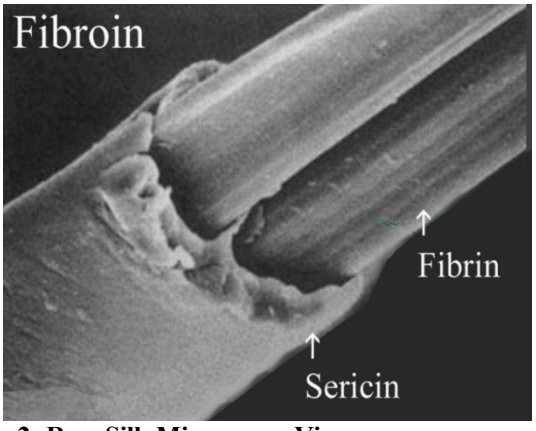

Fig 2: Raw Silk Microscope View

Zhang YQ [2] has explained Silk sericin is a natural macromolecular protein derived from silkworm Bombyx-mori. During the various stages of producing raw silk and textile, sericin can be recovered for other uses. Also, sericin recovery reduces the environmental impact of silk manufacture. Sericin protein is useful because of its properties. The protein resists oxidation, is antibacterial, UV resistant and absorbs and releases moisture easily. Sericin protein can be cross-linked, co-polymerized, and blended with other macromolecular materials, especially artificial polymers, to produce materials with improved properties. The protein is also used as an

improving reagent or a coating material for natural and artificial fibers & fabrics. The materials modified with sericin and sericin composites are useful as degradable biomaterials, biomedical materials, and polymers for forming articles, functional membranes, fibers, and fabrics. Khalid N Jassim & Omar J Alsaree[3] has explained that the protein sericin has good antimicrobial properties, it can inhibit the growing of bacteria & it is possible to use the silk sericin for medical applications after isolation and identification of some pathogenic bacteria like Pseudomonas aeruginosa, Staphyllococcus aureous Escherchia coli to produce medical bandages, mouth wash, antibacterial soaps & teeth paste. Arunee Kongdee and Nuchsirapak Chinthawan[4] have investigated on Cotton fibers modified with silk sericin in a pad-dry-cure process, by using glutaraldehyde/dimethyloldihydroxyethylene urea as cross linking agents. The modification of cotton fibers with sericin using these cross linking agents was clearly proved by dyeing with an acid dye. In samples treated with sericin, the increase in the color strength and b-values, and the decrease in L-values were the proof of the reaction between cellulose and sericin using glutaraldehyde and dimethyloldihydroxyethylene urea as cross linking agents. With increasing sericin concentration in finishing solutions, further increases in the color strength and b-values and decrease in L-values were investigated. The presence of sericin in cotton fibers might improve its comfortablity with regard to the changed fiber surfaces. Kongdee A, Bechtold T. & Teufel, L [5] has modified the Cellulose Fiber with Silk Sericin. From ESEM and FTIR-ATR results, it was found that increasing sericin content in the finishing solution increased the amount of coated sericin, and a greater depth of color in dyed samples and reduced free formaldehyde content in treated samples were observed. The sericin content in samples was found to have a negligible influence on tensile strength and crease recovery angle. With increasing sericin content, electrical resistivity of the samples dramatically decreased and water retention increased, indicating that sericin-treated fabrics may be comfortable to wear because of its maintenance of moisture balance with respect to human skin. M. L. Gulrajani et.al., [6] has studied on application of silk sericin to polyester fabric, Sericin powder was prepared from a boiled solution of silk cocoons through salting-out with ammonium sulfate. The performance properties, such as the moisture content, UV absorption, antistatic, crease recovery, and bending length, of the treated fabric were tested. The amino acid content, nitrogen content, and Kubelka Monk function (*K*/*S*) values of the sericin treated fabric increased with an increase in the concentration of sericin in the padding liquor. The *K*/*S* value of the dyed samples was found to be linearly correlated with the number of amino groups present on the samples. There was a noticeable improvement in the moisture content and antistatic and UV absorption properties of the sericin treated fabrics. Pushpa Bajaj [7] have studied Finishing of textile materials, with increasing awareness of environmental concerns, various chemical finishes for processing of textiles have been discussed.

Material & Methodology:

100% cotton material was treated in this project, with suitable counts and GSM. Construction particulars of the fabric are EPI – 72, PPI-72, GSM-120, Count of warp & weft: 30s X30s. Glutaraldihyde [cross linking agent] & Sericin. Glutaraldihyde is an organic compound. A pungent colourless oily liquid and it is used to disinfect medical and dental equipment, industrial water treatment and as a preservative. It is mainly available as an aqueous solution. Sericin powder was prepared from a boiled solution of silk cocoons through salting-out with ammonium sulphate. The obtained sericin powder has antioxidant, UV protection, moisture absorption, and anti bacterial activity properties.

Preparation of treated cotton fabrics

Ten recipes of finishing solutions composed of Glutaraldihyde and Sericin were prepared accordingly, and concentration of Sericin varied from 20 to 40, 60, 80 and 100 g/L. Hundred percent cotton fabric (30×40 cm2) was padded through the finishing solutions in a laboratory padder. The samples were then dried in a laboratory dryer at 100°C for 2 minutes and cured at 160°C for 2 minutes.

The samples were thoroughly washed in distilled water at 70°C for 30 minutes. The fabrics were padded through the finishing solutions without Sericin added, and it was treated as control.

Testing:

The following tests were conducted for the treated fabric as well as for the controlled samples in order to know the comfort properties as well as anti microbial properties of fabrics.

S. No.	TEST	INSTRUMENT USED	STANDARD
1	Air permeability	Air permeability Tester	ASTMd737-04
2	Wicking	-	AATCC-197-2011
3	FTIR	Ftir-abb bomem spectroscopy (model – mb3000)	ASTM - cf-1228

4	Anti microbial	Agar plate difussion	AATCC 147

Results and Discussion:

Many trials were carried out on Cotton fabric using Sericin gum (1-8%) with Cross linking agent such as Glutaraldihyde (2.5-40ml/lit) and Tri – sodium citrate (8 gpl) with temperature of 100°c for a period of 1 hr. This chapter discusses the properties of fabric samples produced as per experimental plan. Fabric properties involve Air permeability, wickability, absorbency, anti microbial properties and FTIR Studies were analyzed and discussed.

Effect of Sericin gum on Air permeability of Cotton fabric

Cotton fabric has been prepared with 30 ends and 30 picks per inch then it has been treated with Sericin gum with Cross linking agent such as Glutaraldihyde and wetting agent such as Tri-Sodium citrate. The results show that cotton fabric treated with 5% Sericin gum, 20 ml/lit of Glutaraldihyde and 8 gms/lit of Tri-Sodium citrate at a temperature of 100°c for a period of 1 hour gives increase in the Air permeability (445.6 mm/sec) of cotton fabric when compared with the controlled sample (423mm/sec). This may be due to the generation of effective gap between yarns at crossover points and decrease in fibre diameter. Table no.1 shows the Air permeability values in mm/sec of cotton fabric (30x30) at different concentrations of Sericin gum. Air permeability of cotton fabrics tested under the ASTM 737.

Table 1: *Results of Air-permeability and* Thermal resistance Value

S.No.	Sample Name	Sericin concentration	GD	TSC	Air Permeability In mm/Sec	Thermal resistance Value in (m^2 - K/Watt)
1	Bleached Std Sample	-	-	-	443	0.0163
2	A	1%	2.5ml/l	1.5gpl	398.8	0.0161
3	B	2 %	5ml/l	3gpl	411.2	0.0179
4	C	3%	10ml/l	5gpl	381.8	0.0196
5	D	5%	20ml/l	8gpl	445.6	0.0173
6	E	7%	30ml/l	10gpl	437.6	0.0228
7	F	8%	40ml/l	15gpl	389.6	0.0191

Effect of Sericin gum on Wicking of Cotton fabric

Wicking property of cotton fabric has been reduced after it has been treated with Sericin gum with cross linking agents. Table no.2 shows the wicking height of both warp and weft of controlled sample and treated samples. From the table it clearly understood that the absorbency property of cotton fabric after the treatment has reduced drastically. This is because of after the treatment the Sericin gum present in the surface of the fabric acts as a barrier for the water molecules to enter into the fabric.

Fig 3 Controlled sample

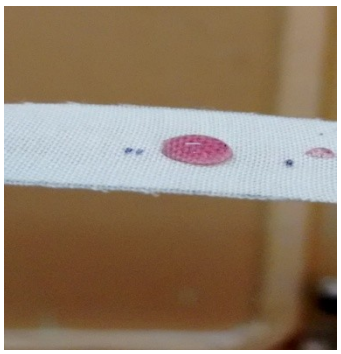

Fig 4 Treated sample

Figure no.1 shows the water repellency of Sericin treated cotton fabric. The water droplet has been put on the fabric to determine its absorbency it clearly shown that up to 5 minutes the water droplet has been in its original state and after that it was slowly absorbed by the fabric. Therefore from these results it is clear that after the Sericin treatment the cotton fabric extended the water repellency property.

Table 2: *Results of Wicking behavior*

S.No	Bleached Std Sample		A		B		C		D		E		F	
Time	Wp	Wf	Wp	Wf	Wp	Wf	Wp	Wf	Wp	Wf	Wp	Wf	Wp	Wf
1 MIN	2.4	2	2.0	0.2	1.8	1.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2 MIN	3.2	2.5	2.5	0.2	2.8	1.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3 MIN	4	3	3.0	0.2	3.6	2.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4 MIN	4.3	3.2	3.3	4.1	4.1	2.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5 MIN	4.9	3.5	3.6	0.2	4.3	2.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

In some applications it requires less absorbency of water and more anti microbial and anti oxidant property. In this case if the sericin is applied in more amounts it is difficult to get water absorbency. In this study the less quantity of sericin is applied and results have been observed. It is observed that if sericin is applied less amount and more cross linking agent than it is possible to get a fabric with anti microbial and anti oxidant property with hydrophobicity.

Conclusion:

After applying sericin on cotton fabric with DMDHEU as a cross linking agent there is no significant change in the air permeability of treated fabric. In case of water absorbency of treated fabrics it is decreased with application of sericin. This is because of application of sericin in less amount when compared with the cross linking agent.

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